Research Article

Effect of Two Cleansing Agents on Color Stability of Two Thermoplastic Denture Base Materials

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Abstract

Aim: Some patients experience adverse reactions to acrylic resin (PMMA) denture base material. Polyamide (PA) as an alternative to PMMA has however not been well documented regarding color stability. The aim of this in vitro study was to evaluate the effect of two different cleansing agents (corega and fittydent), on color stability of two thermoplastic denture base materials (vertex thermosens and breflex).

Materials and methods: A total of 60 samples were fabricated from two different thermoplastic denture base materials (vertex thermosens and breflex). The samples were divided into 3 groups. Each group was including twenty samples, ten samples each for vertex thermosens and 10 from breflex denture base materials. Samples of Group I were subjected to the distilled water as a control group. While samples of Group II were subjected to the corega as a cleansing agent and samples of group III were subjected to fittydent as the other cleansing agent. Effect of the two cleansing agents on the two-different thermoplastic denture base materials were evaluated and compared with regards to color stability.

Results: Regarding (vertex thermosens and breflex) both materials were relatively color stable in the two cleansing agents. Corega had less effect on color change than fittydent.

Conclusion: Corega and fittydent cleansing agents could be used safely for disinfecting denture base materials (vertex thermosens and breflex) as they had non-significant effect on color stability.

INTRODUCTION

Many material have been used for denture base construction as acrylic resin (PMMA), nylon, poly either, etc. Unnecessary if acrylic should be mentioned at all, it should only be used to introduce the thermoplastic materials as an alternative [1].

Nylon is an alternative to acrylic resin as a denture base material and is a generic name for certain types of thermoplastic polymers known as polyamides. Nylon is a crystalline polymer, but PMMA is amorphous. This crystalline nature has a little liability to changes in physical and mechanical prosperities as has a few inter structural spaces for entrance of water, saliva and cleansing agents [2].

Color change within the denture base (PMMA) may be caused by the oxidation of the amine accelerator or by the penetration of colored solutions (nylon and PMMA). Most materials used for prosthetic treatment are subject to sorption, a process of absorption and adsorption of liquids dependent on environmental conditions [3]. Color change may be associated with porosity caused by overheating or insufficient pressure during polymerization or to excessive residual monomer; surface characteristics and microporosity in the specimens [3]. Staining of acrylic resins can lead to poor esthetics [3].

Color change of denture base materials may result in patient dissatisfaction and additional expense for replacement. Determination of color by visual means is considered highly subjective [4]. Methods used to assess changes in shade include digital analysis, projection of photographic slides, visual group ranking, and shade guide matching [4].

The spectrophotometer evaluates visible light through the color spectrum (400-700 nm) and expresses the analysis as a numerical value and is accurate method and avoids the human errors in visual methods [5]. Disinfection method should be effective without detrimental effects on the properties of materials used for fabrication of denture base. Everyday use of denture cleansers is recommended to prevent microbial colonization on denture and promote good oral health. Daily use of denture cleansers can affect the color stability of denture base material. In choosing a disinfectant for a dental prosthesis, consideration should be given to its compatibility with the type of material to be disinfected to avoid adverse effects [6,7].

MATERIALS AND METHODS

In this in-vitro study, a total of 60 samples were made from two different thermoplastic denture base materials (vertex
thermosens, Vertex-Dental B.V. Headquarters Netherlands) and (breflex, breidentWeissenhorner Germany). The samples were divided into 3 groups (Figure 1).

**Preparation of metal discs**

Metal disc shape patterns for water sorption and water solubility (50 ± 1 mm in diameter and 0.5 ± 0.05 mm) thick were fabricated from a private engineering works by laser cutting according to ADA specification no. 12. These metal disks were used to prepare the samples for the two denture base materials [8] (Figure 2).

**Preparation of samples**

Samples of this study were prepared according to the manufacture instructions by injecting thermoplastic materials into special flasks with holes to receive the capsule that contained the powder of thermoplastic material [9]. The flask filled with plaster then the metal disk was put in the flask to make a mould. The sprue of the soft wax was applied to the injection channel of the flask contained the sample metal disk impeded in the plaster.

The two halves of the flask were assembled and fastened with screws. The plaster was let to harden. The flasks were placed for 10 minutes in 70°C water to soften the wax. The flasks were opened, and the wax were removed and cleaned with boiling water. The plaster was separated with Thermo-Flow isolation. The flasks were preheated for 15 minutes in ≥ 90°C water and were put in the machine just before injection. The injection with 6.5 bars of pressure was started after 16 minutes of preheating of the cartridge at 250°C. The complete flasks were placed in an oven (>100°C) or in boiling water for 30 minutes. In order to achieve optimal quality of the material, the flasks were bench cooling for 20 minutes and it was then opened.

The samples were taken carefully, and the injection channels were cut off. The edges were ground with the cross standard bur. The surface was polished with silicone polishers. Thermo-Gloss and a microfiber polishing brush were used for finishing. The finish was completed with the brush felt cloth.

**Color stability evaluation**

The spectrophotometer and the International Commission on Illumination (CIE) concept were used to carry out this test by measuring the light absorption of each specimen before and after immersion into corega and fittydent cleansing agents [10-12].

The apparatus used in measurements was AgilentCary5000spectrophotometers. It was manufactured according to a quality management system certified to ISO 9001.1 The basic CIE concept is that all colors can be matched by mixing relative amounts of the three light primaries: Red (X), Green (Y), and Blue (Z) [10]. These can then be transformed to L* is a measure of lightness. The a* value represents positions on a red-green axis. As a* becomes more positive in value, the color is more red; as a* becomes more negative in value, the color becomes more green. The b* value represents positions on a yellow- blue axis. As b* becomes more positive in value, the color becomes more yellow; as b* becomes more negative in value, the color becomes more blue [10].

The equation utilized for calculating color differences in this system10:

\[
\Delta E (\text{Color Changes Value}) = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}
\]

where \(\Delta L, \Delta a\) and \(\Delta b\) are the differences in L, a and b values before and after immersion at each time interval. For this study, the \(\Delta E\) result is used for analysis.

National Bureau of Standards (NBS) is used to quantify the color change. Critical marks of color difference according to NBS are shown in Table 1. Following formula is used to express NBS units.

\[\text{NBS unit} = \Delta E \times 0.92\], Where \(\Delta E\) stands for color change.

The samples were fixed to the spectrophotometer holder and the machine was turned on then the samples were tested.

All samples were evaluated for color stability before and after immersion in cleansing agents and water to evaluate the effect of cleansing agents (Figure 3 and 4).

**RESULTS**

**Color stability**

1 Cary 5000 Spectrophotometer provided from Agilent Technologies(USA).
Comparison of color stability of the Thermoplastic denture base material in different cleansing agents: The results of comparison between the different groups as regarding color change are shown in Table 2 and Figure 5.

The values of the color changes (ΔE) of vertex thermosens when immersed in water, corega and fittydent in comparison showed no significant difference (P-value = 0.9425).

The values of the color changes (ΔE) of breflex when immersed in water, corega, fittydent in comparison showed no significant difference (p-value = 0.072).

Comparison of color change of the Thermoplastic denture base materials utilizing different cleansing agents using National Bureau of Standards (NBS)

The mean values of color change expressed in NBS units are shown in Table 3 and Figure 6.

The results revealed that all the groups showed slight change in color as interpreted Critical remarks of color difference with NBS values ranging from 0.5-1.5indicating slight color change.

DISCUSSION

Nylon with relatively low water sorption levels and melting points, was developed to overcome problems with earlier forms of denture base materials [8]. It was modified by reinforcement with glass fiber and glass spheres to increase its potential use as a denture base material. This modified material showed color stability [8].

Color stability has a long term effect on the esthetics of the denture which is a very important requirement for patient satisfaction [13]. Water sorption and solubility affect the
were changes in color stability when immersed in beverages such as coffee, cleansing agents, tea, or wine. The tannic acid contained in coffee and tea are water-soluble and are known to trigger brown pigmentation.

Denture cleansers cause loss of soluble component and plasticizers from the denture base resins. Higher ionic concentration of denture cleansers compared to water led to a higher release of soluble components. Further absorption of water and other salivary components by the denture base materials leads to surface roughness and color change [23,24].

In the study of Lai et al. [25], The color stability of copolyamide, silicone and heat-polymerized acrylic resins as removable gingival flange materials were evaluated by a spectrophotometer after 7, 14, 30, 120, and 180 days of immersion in staining solutions of coffee and tea. Copolyamide had the greatest staining in tea solution and the silicone material in coffee solution. The color changes of silicone and copolyamide materials stored in coffee solution for 180 days were greater than 3 NBS (National Bureau of Standards) units, which would be characterized considerable and deliberated clinically unacceptable.

Takabayashi [26], Compared the color stability of six thermoplastic denture resin materials (three polyamides, two polycarbonates and a polyethylene terephthalate) after being soaked in coffee and curry solutions for 60 hours. In that study, three polyamides had considerable color change in the curry solution and two of them showed considerable color change after soaking in the coffee solution.

It was found that the frequency of amide groups along the chain had affected the color stability, water sorption and the chemical properties of each type of nylon. Another attributed reason could be the differences in finishing and polishing of nylon materials compared to PMMA. Rougher surfaces are more susceptible to staining [27,28].

The effects of three sodium perborate-containing denture cleansers (Corega, PR-Protefix, VA-Valclean) were evaluated on the surface roughness, hardness, and color stability of two polyamides (Valplast and Deflex), a butadiene styrene copolymer PMMA, and a PMMA polymer as a control group. Surface roughness of the polyamide increased after 20 days of repeated immersion regardless of the type of the solution used. Valplast had a higher initial surface roughness which increased after the immersion. This study also showed that no changes occurred in the color of polyamides in these solutions.

The study evaluated the effects of two denture cleansing methods [Val-Clean (peroxide cleanser) and Corega plus microwaving] on 3-D surface roughness, gloss and color of

Table 1: Critical remarks of color difference NBS units

<table>
<thead>
<tr>
<th>Critical remarks of color difference</th>
<th>NBS units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>0.0-0.5</td>
</tr>
<tr>
<td>Slight</td>
<td>0.5-1.5</td>
</tr>
<tr>
<td>Noticeable</td>
<td>1.5-3.0</td>
</tr>
<tr>
<td>Appreciable</td>
<td>3.0-6.0</td>
</tr>
<tr>
<td>Much</td>
<td>6.0-12.0</td>
</tr>
<tr>
<td>Very much</td>
<td>12.0±</td>
</tr>
</tbody>
</table>

Table 2: Mean values, SD, and comparison for color changes between different groups.

<table>
<thead>
<tr>
<th>Cleansing agents</th>
<th>Water Mean</th>
<th>SD</th>
<th>Corega Mean</th>
<th>SD</th>
<th>Fittydent Mean</th>
<th>SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoplastic denture base materials</td>
<td>1.019</td>
<td>0.072</td>
<td>1.075</td>
<td>0.0987</td>
<td>1.094</td>
<td>0.0148</td>
<td>0.9425</td>
</tr>
<tr>
<td>Vertex thermosens</td>
<td>0.989</td>
<td>0.086</td>
<td>1.053</td>
<td>0.115</td>
<td>1.119</td>
<td>0.0916</td>
<td>0.0719</td>
</tr>
<tr>
<td>Breflex</td>
<td>-0.034</td>
<td>0.0865</td>
<td>-0.025</td>
<td>0.0153</td>
<td>0.106</td>
<td>0.711</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.9153</td>
<td>0.106</td>
<td>0.711</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
nylon (Valplast), and heat-polymerized acrylic PMMA denture base material for a period simulating 30 days of daily cleansing, by using an interferometric profilometer, a gloss meter, and a colorimeter. The results of this study showed that cleansing methods had no different effect on color group compared with the control group, when using the same material. However, the effect on Valplast was higher than PMMA, both at a clinically perceptible level.

The Val-Clean method was the only method that had no particular influence on the gloss of both tested materials. Corega plus microwaves significantly decreased the gloss of both materials. Surface roughness was affected significantly only by Corega plus microwaves and only for the PMMA material. The color change (as an effect of cleansing agent), was not associated with gloss or surface roughness in any of the materials. However, gloss and surface roughness were highly associated in PMMA and could be used for the prediction of each other

The present study showed that fittydent cleansing agent had the highest value of color changes when compared to water and corega, but the differences were insignificance and this may be due to that fittydent cleansing agent contain potassium mono sulfate and sodium bicarbonate which not contained in corega that may react with the coloring agents of the denture base materials used in this study not only that but also may increase the surface porosity.

CONCLUSION

1. Based on the results of this study, we can conclude that cleansing agents had no noticeable effect on the color stability of the recent denture base materials (vertex thermosens and Breflex).

2. Non significant differences were found between vertex thermosens and Breflex denture base materials with the use of different cleansing agents (corega, fittydent, water) regarding color stability.

REFERENCES


